

Poliomyelitis

THE WORDS POLIO (GREY) AND MYELON (MARROW, INDICATING THE spinal cord) are derived from the Greek. It is the poliomyelitis virus effect on the spinal cord that leads to the classic manifestation, paralysis.

Although records from antiquity mention crippling diseases compatible with poliomyelitis, it was Michael Underwood from Britain who, in 1789, first described a debility of the lower extremities in children that was recognizable as poliomyelitis. The first outbreaks in Europe were reported in the early 19th century, and outbreaks were reported in the United States a few years later. For the next hundred years, epidemics of polio were reported from developed countries in the northern hemisphere each summer and fall. These epidemics became increasingly severe, and the average age of persons affected rose. The increased age of primary infection increased both the disease severity and number of deaths from polio. Polio reached a peak in the United States in 1952, with over 21,000 paralytic cases. Polio incidence fell rapidly following introduction of effective vaccines. The last case of wild-virus polio acquired in the United States was in 1979, and global polio eradication may be achieved within the next decade.

Poliovirus

Poliovirus is a member of the enterovirus subgroup, family Picornaviridae. Enteroviruses are transient inhabitants of the gastrointestinal tract, and are stable at acid pH. Picornaviruses are small, ether-insensitive viruses with an RNA genome.

There are three poliovirus serotypes (P1, P2, and P3). There is minimal heterotypic immunity between the three serotypes.

The poliovirus is rapidly inactivated by heat, formaldehyde, chlorine, and ultraviolet light.

Poliomyelitis

- First described by Michael Underwood in 1789
- First outbreak described in U.S. in 1843
- 21,000 paralytic cases reported in the United States in 1952
- Global eradication

Poliovirus

- Enterovirus (RNA)
- Three serotypes: 1, 2, 3
- Minimal heterotypic immunity between serotypes
- Rapidly inactivated by heat, formaldehyde, chlorine, ultraviolet light

Poliomyelitis Pathogenesis

- Entry into mouth
- Replication in pharynx, GI tract, local lymphatics
- Hematologic spread to lymphatics and central nervous system
- Viral spread along nerve fibers
- Destruction of motor neurons

Pathogenesis

The virus enters through the mouth and primary multiplication of the virus occurs at the site of implantation in the pharynx and gastrointestinal tract. The virus is usually present in the throat and in the stools before the onset of illness. One week after onset there is little virus in the throat, but virus continues to be excreted in the stools for several weeks. The virus invades local lymphoid tissue, enters the blood stream, and then may infect cells of the central nervous system. Replication of poliovirus in motor neurons of the anterior horn and brain stem results in cell destruction and causes the typical manifestations of poliomyelitis.

Clinical Features

The **incubation period** for poliomyelitis is commonly 6 to 20 days with a range from 3 to 35 days.

The response to poliovirus infection is highly variable and has been categorized based on the severity of clinical presentation.

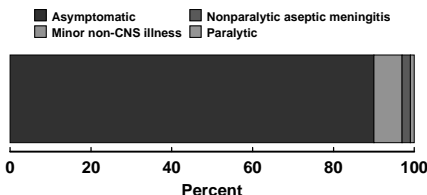
Up to 95% of all polio infections are **inapparent or sub-clinical without symptoms**. Estimates of the ratio of inapparent to paralytic illness vary from 50:1 to 1,000:1 (usually 200:1). Infected persons without symptoms shed virus in the stool, and are able to transmit the virus to others.

Approximately 4%-8% of polio infections consist of a **minor, nonspecific illness** without clinical or laboratory evidence of central nervous system invasion. This syndrome is known as abortive poliomyelitis, and is characterized by complete recovery in less than a week. Three syndromes observed with this form of poliovirus infection are upper respiratory tract infection (sore throat and fever), gastrointestinal disturbances (nausea, vomiting, abdominal pain, constipation or, rarely, diarrhea), and influenza-like illness. These syndromes are indistinguishable from other viral illnesses.

Nonparalytic aseptic meningitis (symptoms of stiffness of the neck, back, and/or legs), usually following several days after a prodrome similar to that of minor illness, occurs in 1%-2% of polio infections. Increased or abnormal sensations can also occur. Typically these symptoms will last from 2 to 10 days, followed by complete recovery.

Less than 2% of all polio infections result in **flaccid paralysis**. Paralytic symptoms generally begin 1 to 10 days after prodromal symptoms and progress for 2 to 3 days.

Outcomes of poliovirus infection



Generally, no further paralysis occurs after the temperature returns to normal. The prodrome may be biphasic, especially in children, with initial minor symptoms separated by a 1- to 7-day period from more major symptoms. Additional prodromal signs and symptoms can include a loss of superficial reflexes, initially increased deep tendon reflexes and severe muscle aches and spasms in the limbs or back. The illness progresses to flaccid paralysis with diminished deep tendon reflexes, reaches a plateau without change for days to weeks, and is usually asymmetrical. Strength then begins to return. Patients do not experience sensory losses or changes in cognition.

Many persons with paralytic poliomyelitis recover completely and, in most, muscle function returns to some degree. Patients with weakness or paralysis 12 months after onset will usually be left with permanent residua.

Paralytic polio is classified into three types, depending on the level of involvement. **Spinal polio** is most common, and accounted for 79% of paralytic cases from 1969-1979. It is characterized by asymmetric paralysis that most often involves the legs. **Bulbar polio** accounted for 2% of cases and led to weakness of muscles innervated by cranial nerves. **Bulbospinal polio** accounted for 19% of cases and was a combination of bulbar and spinal paralysis.

The death-to-case ratio for paralytic polio is generally 2%-5% in children and up to 15%-30% in adults (depending on age). It increases to 25%-75% with bulbar involvement.

Laboratory Diagnosis

Viral isolation

Poliovirus may be recovered from the stool or pharynx of a person with presumed poliomyelitis. Isolation of virus from the cerebrospinal fluid (CSF) is diagnostic, but is rarely accomplished.

If poliovirus is isolated from a person with acute flaccid paralysis, it must be tested further, using oligonucleotide mapping (fingerprinting) or genomic sequencing, to determine if the virus is “wild-like” or “vaccine-like.”

Serology

Neutralizing antibodies appear early and may be at high levels by the time the patient is hospitalized and, therefore, a 4-fold rise may not be demonstrated.

Cerebrospinal fluid (CSF)

The CSF in poliovirus infection usually contains an increased number of white blood cells (10 to 200 cells/mm³, primarily lymphocytes) and a mildly elevated protein from 40 to 50 mg/100 ml.

Epidemiology

Occurrence

At one time poliovirus infection occurred throughout the world. Transmission of wild poliovirus ceased in the United States in 1979, or possibly earlier. A polio eradication program conducted by the Pan American Health Organization led to elimination of polio through the Western Hemisphere in 1991. The Global Polio Eradication Program has dramatically reduced poliovirus transmission throughout the world. Poliovirus transmission now occurs primarily in the Indian subcontinent, the Eastern Mediterranean, and Africa.

Poliovirus Epidemiology

- **Reservoir** Human
- **Transmission** Fecal-oral
Oral-oral possible
- **Communicability** 7-10 days before onset
Virus present in stool
3-6 weeks

Reservoir

Humans are the only known reservoir of poliovirus, which is transmitted most frequently by persons with inapparent infections. There is no asymptomatic carrier state except in immune deficient persons.

Transmission

Person-to-person spread of poliovirus via the fecal-oral route is the most important route of transmission, although the oral-oral route may account for some cases.

Temporal pattern

Poliovirus infection typically peaks in the summer months in temperate climates. There is no seasonal pattern in tropical climates.

Communicability

Poliovirus is highly infectious, with seroconversion rates in susceptible household contacts of children nearly 100% and over 90% in susceptible household contacts of adults. Cases are most infectious from 7 to 10 days before and after the onset of symptoms, but poliovirus may be present in the stool from 3 to 6 weeks.

Secular Trends in the United States

Before the 18th century, polioviruses probably circulated widely. Initial infections to at least one type probably occurred in early infancy, when transplacentally acquired maternal antibodies were high. Exposure throughout life probably provided continual boosting of immunity and paralytic infections were probably rare. (This view has been recently challenged based on data of lameness studies in developing countries.)

In the immediate pre-vaccine era, improved sanitation allowed less frequent exposure and increased the age of primary infection. There was infrequent boosting of immunity from natural exposure, pooling of susceptibles, and ultimately the occurrence of epidemics, with 13,000 to 20,000 paralytic cases reported annually.

In the early vaccine era, the incidence dramatically decreased following IPV introduction in 1955. The decline continued following OPV introduction in 1961. In 1960, a total of 2,525 paralytic cases were reported, compared with 61 in 1965.

The last cases of paralytic poliomyelitis caused by endemic transmission of wild virus in the United States were in 1979, when an outbreak occurred among the Amish in several Midwest states. The virus was imported from the Netherlands.

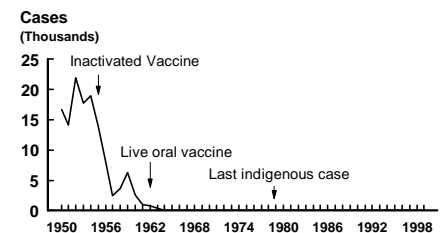
From 1980 through 1999, a total of 152 confirmed cases of paralytic poliomyelitis were reported, an average of 8 cases per year. Six cases were acquired outside the United States and imported. The last imported case occurred in 1993. Two cases were classified as indeterminant (no poliovirus isolated from samples obtained from the patients, and these persons had no history of recent vaccination or direct contact with a vaccine recipient). The remaining 144 (95%) cases were vaccine-associated paralytic polio (VAPP) caused by live oral polio vaccine.

In order to eliminate VAPP from the United States, ACIP recommended in 2000 that IPV be used exclusively in the United States.

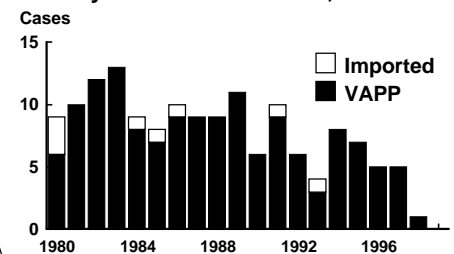
Outbreaks of poliomyelitis in the United States since 1970

In 1970, on the Texas-Mexico border, 22 cases of polio occurred, all in children 4 years of age or less. In 1972, in a Christian Science school in Connecticut, eight cases of paralytic poliomyelitis and three of non-paralytic occurred

Poliomyelitis - United States, 1950-1999



Poliomyelitis - United States, 1980-1999



in persons from 7 to 18 years of age. In 1979 ten paralytic and five non-paralytic cases of poliomyelitis occurred among the Amish in Pennsylvania, Missouri, Iowa and Wisconsin. The mean age of these cases was 12 years. These were the last documented cases of indigenous transmission of wild poliovirus in the United States.

Poliovirus Vaccines

Poliovirus Vaccine

- 1955 Inactivated vaccine
- 1961 Types 1 and 2 monovalent OPV
- 1962 Type 3 monovalent OPV
- 1963 Trivalent OPV
- 1987 Enhanced IPV (IPV)

Inactivated (Salk) poliovirus vaccine (IPV) was licensed in 1955 and was used extensively from that time until the early 1960s. In 1961, type 1 and 2 monovalent oral poliovirus vaccine (MOPV) was licensed, and in 1962, type 3 MOPV was licensed. In 1963, trivalent oral poliovirus vaccine (OPV) was licensed and largely replaced IPV use. OPV has been the vaccine of choice in the United States and most other countries of the world since 1963. An enhanced-potency IPV was licensed in November 1987, and first became available in 1988.

Characteristics

Inactivated poliovirus vaccine (IPV)

Two enhanced forms of inactivated poliovirus vaccine are currently licensed in the United States, but only one vaccine (IPOL, Pasteur Merieux Connaught) is actually distributed. This vaccine contains all three serotypes of polio vaccine virus. The viruses are grown on a type of monkey kidney tissue culture (Vero cell line) and inactivated with formaldehyde. The vaccine contains 2-phenoxyethanol, and trace amounts of neomycin, streptomycin, and polymyxin B. It is supplied in a single dose prefilled syringe, and should be administered by subcutaneous injection.

Oral poliovirus vaccine (OPV)

Trivalent OPV contains live attenuated strains of all three serotypes of poliovirus in a 10:1:3 ratio. The vaccine viruses are propagated in monkey kidney cell culture. The vaccine is supplied as a single 0.5 ml dose in a plastic dispenser. The vaccine contains trace amounts of streptomycin and neomycin. OPV does not contain a preservative.

Live attenuated polioviruses replicate in the intestinal mucosa and lymphoid cells, and in lymph nodes that drain the intestine. Vaccine viruses are excreted in the stool of the vaccinated person for up to six weeks after a dose. Maximum viral shedding occurs in the first 1-2 weeks after vaccination.

Inactivated Polio Vaccine

- Contains 3 serotypes of vaccine virus
- Grown on monkey kidney (Vero) cells
- Inactivated with formaldehyde
- Contains 2-phenoxyethanol, neomycin, streptomycin, polymyxin B

Oral Polio Vaccine

- Contains 3 serotypes of vaccine virus
- Grown on monkey kidney (Vero) cells
- Contains neomycin, streptomycin
- Shed in stool for up to 6 weeks following vaccination

Vaccine viruses may spread from the recipient to contacts. Persons coming in contact with fecal material of a vaccinated person may be exposed and infected with vaccine virus.

Immunogenicity and vaccine efficacy

IPV

IPV is highly effective in producing immunity to polio virus, and protection from paralytic poliomyelitis. A single dose of IPV produces little or no immunity. Ninety percent or more of vaccine recipients develop protective antibody to all three poliovirus types after 2 doses, and at least 99% are immune following 3 doses. Protection against paralytic disease correlates with the presence of antibody.

IPV appears to produce less local gastrointestinal immunity than does OPV, so persons who receive IPV are more readily infected with wild polio virus than OPV recipients. A person who received IPV could become infected with wild polio virus in an endemic area and could be shedding wild virus upon return to the United States. The infected person would be protected from paralytic polio, but the wild virus being shed in the stool could spread and result in transmission to a contact.

The duration of immunity to IPV is not known with certainty, although it probably provides protection for many years after a complete series.

OPV

OPV is highly effective in producing immunity to poliovirus. A single dose of OPV produces immunity to all three vaccine viruses in about 50% of recipients. Three doses produces immunity to all 3 poliovirus types in more than 95% of recipients. As with other live virus vaccines, immunity from oral poliovirus vaccine is probably lifelong.

OPV produces excellent intestinal immunity which helps prevent infection with wild virus. This characteristic is important, because it reduces the chance that a vaccinated person will become infected with wild virus if he or she is exposed while visiting a polio endemic country. Intestinal resistance to infection would also help to minimize spread in the United States if an importation of wild virus were to occur.

Inactivated Polio Vaccine

- Highly effective in producing immunity to poliovirus
- Little or no immunity after 1 dose
- 90% immune after 2 doses
- 99% immune after 3 doses

Oral Polio Vaccine

- Highly effective in producing immunity to poliovirus
- 50% immune after 1 doses
- >95% immune after 3 doses
- Produces intestinal immunity and resistance to infection with poliovirus

Serologic studies have shown that seroconversion following three doses of either IPV or OPV are nearly 100% to all three vaccine viruses. However, seroconversion rates after three doses of a **combination of IPV and OPV** are lower, particularly to type 3 vaccine virus (as low as 85% in one study). A fourth dose (most studies used OPV as the fourth dose) usually produces seroconversion rates similar to three doses of either IPV or OPV.

Vaccination Schedule and Use

Polio Vaccination Recommendations, 1996-1999

- Increased use of IPV (sequential IPV-OPV schedule) recommended in 1996
- Intended to *reduce* the risk of vaccine-associated paralytic polio (VAPP)
- Continued risk to contacts of OPV recipients

Trivalent oral polio vaccine was the vaccine of choice in the United States (and most other countries of the world) since it was licensed in 1963. The nearly exclusive use of OPV led to elimination of wild-type poliovirus from the United States in less than 20 years. However, one case of vaccine-associated paralytic polio (VAPP) occurred for every 2 to 3 million doses of OPV administered, which resulted in 8 to 10 cases of VAPP each year in the United States (see Adverse Reactions section for more details on VAPP). Since 1980, VAPP has accounted for 95% of all cases of paralytic poliomyelitis reported in the United States.

ACIP recommended an increase in use of IPV through a sequential schedule of IPV followed by OPV in 1996. This recommendation was intended to *reduce* the occurrence of vaccine-associated polio. The sequential schedule was expected to eliminate VAPP among vaccine recipients by producing humoral immunity to polio vaccine viruses with inactivated polio vaccine prior to exposure to live vaccine virus. Since OPV was still used for the third and fourth doses of the polio vaccination schedule, there would continue to be a risk of VAPP among contacts of vaccinees, who were exposed to live vaccine virus in the stool of vaccine recipients.

Polio Vaccination Recommendations 2000

- ACIP recommends exclusive use of inactivated polio vaccine in the United States beginning in 2000
- OPV should be used only in special circumstances

The sequential IPV-OPV polio vaccination schedule was widely accepted by both providers and parents. The number of doses of IPV ordered through the federal vaccine contract increased substantially in 1997-1998, and polio vaccination coverage of infants and young children did not decline. In addition, fewer cases of VAPP were reported in 1998 and 1999, suggesting an impact of the increased use of IPV. However, only the complete discontinuation of use of OPV would lead to complete elimination of VAPP. To order to further the goal of complete elimination of paralytic polio in the United States, **ACIP recommended in July 1999 that inactivated polio vaccine be used exclusively in the United States beginning in 2000.** Exclusive use of inactivated polio

vaccine will eliminate the shedding of live vaccine virus, and totally eliminate any risk of vaccine associated poliomyelitis.

A primary series of inactivated polio vaccine consists of three doses. In infancy, these primary doses are integrated with the administration of other routinely administered vaccines. The first dose may be given as early as 6 weeks of age, but is usually given at 2 months of age, with a second dose at 4 months of age. The third dose should be given 6 to 18 months of age. The first and second doses of IPV are necessary to induce a primary immune response, and the third dose of IPV ensures "boosting" of antibody titers to high levels. The preferred interval between the second and third doses of IPV is 2-8 months. However, if accelerated protection is needed, the minimum interval between doses of IPV is 4 weeks. Children who receive three doses of IPV before the fourth birthday should receive a fourth dose before or at school entry. The fourth dose is not needed if the third dose is given on or after the fourth birthday. It is not necessary to repeat or add doses if the interval between doses is prolonged.

An all-IPV schedule is the preferred schedule for routine polio vaccination of children in the United States, including children who began their polio vaccination series with OPV. If a child receives both types of vaccine, **four doses of any combination of IPV or OPV** by 4-6 years of age is considered a complete poliovirus vaccination series. A minimum interval of 4 weeks should separate all doses of the series.

Availability of OPV is expected to be limited in the future in the United States. The Federal Government no longer has a purchasing contract for OPV, and the manufacturer will probably cease production within 2 years (OPV will continue to be manufactured and used outside the United States). In the interim, OPV should be used only for certain special circumstances. Unvaccinated children who will be traveling in less than 4 weeks to areas where polio is endemic may receive a dose of OPV (*i.e.*, only one dose of polio vaccine can be given before travel). A single dose of OPV is more likely to produce immunity to poliovirus than a single dose of IPV. If 4 weeks or more are available before travel, at least 2 doses of IPV are recommended. OPV may be used for the third or fourth dose of the polio vaccination series for children whose parents will not accept the additional number of injections required to complete the polio vaccination series with IPV. Providers should administer OPV only after discussing the risk for VAPP with parents or caregivers.

Recommended Childhood Polio Vaccination Schedule 2000

Age	Vaccine	Minimum Interval
2 months	IPV	---
4 months	IPV	4 wks
6-18 months	IPV	4 wks
4-6 years	IPV	4 wks

Schedules that Include Both IPV and OPV

- Exclusive use of IPV preferred, including children who have received one or more doses of OPV in the past
- Any combination of 4 doses of IPV and OPV by 5 years constitutes a complete series

Situations Where OPV Use May Be Considered

- OPV *not recommended* for routine polio vaccination or for first two doses under any circumstances
- Unvaccinated child traveling to polio-endemic area in <4 weeks
- Parents refuse additional injections (third and fourth dose *only*)

Poliovirus Vaccination of Adults

- Routine vaccination of U.S. residents ≥ 18 years of age not necessary
- May consider vaccination of some adults at greater risk of exposure to poliovirus:
 - travelers to endemic areas
 - selected laboratory workers
 - selected health-care workers

Polio Vaccination of Adults

Routine vaccination of adults (>18 years of age) who reside in the United States is not necessary because most adults are already immune and have a very small risk of exposure to wild poliovirus in the United States.

Some adults are at increased risk of infection with poliovirus. These include travelers to areas where poliomyelitis is endemic or epidemic, laboratory workers handling specimens that may contain polioviruses, and health-care workers in close contact with patients who may be excreting wild polioviruses. In addition, members of specific population groups with a current disease caused by wild polioviruses (*e.g.*, during an outbreak), are also at increased risk.

Recommendations for poliovirus vaccination of adults in the above categories depend upon the previous vaccination history and the time available before protection is required.

Poliovirus Vaccination of Unvaccinated Adults

- IPV preferred
- Use standard IPV schedule if possible (0, 1-2 months, 6-12 months)
- May separate doses by 4 weeks if accelerated schedule needed

For **unvaccinated adults** at increased risk of exposure to poliomyelitis, primary immunization with IPV is recommended. IPV is preferred because the risk of vaccine-associated paralysis following OPV is higher in adults than in children. The recommended schedule is two doses given at a 1- to 2-month interval, and a third dose given 6 to 12 months later.

In some circumstances time will not allow completion of this schedule. If 8 weeks or more are available before protection is needed, three doses of IPV should be given at least 4 weeks apart. If 4-8 weeks are available before protection is needed, two doses of IPV should be given at least 4 weeks apart. If less than 4 weeks are available before protection is needed, a single dose of either OPV or IPV is recommended. In all instances, the remaining doses of vaccine should be given later, at the recommended intervals, if the person remains at increased risk.

Poliovirus Vaccination of Previously Vaccinated Adults

- Previously complete series
 - Administer one dose of OPV or IPV
- Incomplete series
 - Administer remaining required doses
 - IPV should be used
 - No need to restart series

Adults who have previously completed a primary course of OPV and who are at increased risk of exposure to poliomyelitis may be given another dose of OPV (if available). These adults are not at increased risk of VAPP. The need for further supplementary doses has not been established. Those adults who previously completed a primary course of IPV and are at increased risk may be given a dose of either IPV or OPV.

Adults who have previously received less than a full primary course of OPV or IPV and who are at increased risk of exposure to poliomyelitis should be given the remaining doses of IPV, regardless of the interval since the last dose and type of vaccine previously received. It is not necessary to restart the series of either vaccine if the schedule has been interrupted.

Adverse Reactions Following Vaccination

Minor **local reactions** (pain, redness) may occur following IPV. No serious adverse reactions to IPV have been documented. Because IPV contains trace amounts of streptomycin, polymyxin B, and neomycin, **allergic reactions** may occur among persons sensitive to these antibiotics.

In rare instances, administration of OPV has been associated with paralysis in healthy recipients and their contacts. No procedures are currently available for identifying persons, other than those with immunodeficiency, who are likely to experience such adverse reactions. Although the risk of **vaccine-associated paralysis** is minimal, vaccinees (or their parents) and their susceptible, close, personal contacts should be informed of this risk.

Vaccine-Associated Paralytic Poliomyelitis (VAPP)

Vaccine-associated paralytic polio (VAPP) is a rare adverse event following live oral poliovirus vaccine. Inactivated poliovirus vaccine does not contain live virus, so it cannot cause VAPP. The mechanism of VAPP is believed to be a mutation, or reversion, of the vaccine virus to a more neurotropic form. These mutated viruses are called revertants. Reversion is believed to occur in almost all vaccine recipients, but it only rarely results in paralytic disease. The paralysis that results is identical to that caused by wild virus, and may be permanent.

VAPP is more likely to occur in persons >18 years of age than in children, and is much more likely to occur in immunodeficient children than in those who are immunologically normal. Compared with immunocompetent children, the risk of VAPP is almost 7000 times higher for persons with certain types of immunodeficiencies, particularly B lymphocyte disorders (*e.g.*, agammaglobulinemia and hypogammaglobulinemia) which reduce the synthesis of immune globulins. There is no procedure available for identifying persons at risk of paralytic disease, except excluding older persons and screening for immunodeficiency. VAPP is usually permanent.

Polio Vaccines Adverse Reactions

- Local reactions uncommon
- Allergic reactions very rare
- Paralytic poliomyelitis (VAPP) following OPV

Vaccine-Associated Paralytic Polio

- Increased risk in persons >18 years
- Increased risk in persons with immunodeficiency
- No procedure available for identifying persons at risk of paralytic disease
- Usually permanent

Vaccine-Associated Paralytic Polio (VAPP) 1980-1998

• Healthy recipients of OPV	59 (41%)
• Healthy contacts of OPV recipients	44 (31%)
• Community acquired	7 (5%)
• Immunodeficient	34 (24%)
• Total	144

From 1980 through 1998, 152 persons with paralytic polio were reported in the United States; 144 (95%) of these cases were VAPP, and the remaining 8 persons acquired documented or presumed wild virus polio outside the U.S. Of the 144 VAPP cases reported during 1980-1998, 59 (41%) occurred in healthy vaccine recipients (average age 3 months). Forty-four (31%) occurred in healthy contacts of vaccine recipients (average age 26 years), and 7 (5%) were community acquired (i.e., vaccine virus recovered but there was no known contact with a vaccine recipient). Thirty-four (24%) of VAPP cases occurred in persons with immunologic abnormalities (27 in vaccine recipients and 7 in contacts of vaccine recipients). None of the vaccine recipients were known to be immunologically abnormal prior to vaccination.

Risk of VAPP Among OPV Recipients - 1980-1995

Number of cases	49
Overall (all doses)	1:6.2 million
First dose	1:1.4 million (n=40)
Subsequent doses	1:27.2 million (n=9)

The risk of VAPP is not equal for all OPV doses in the vaccination series. The risk of VAPP is 7 to 21 times higher for the first dose than for any other dose in the OPV series. From 1980 through 1994, 303 million doses of OPV were distributed and 125 cases of VAPP were reported, for an overall risk of VAPP of 1 case per 2.4 million doses. Forty-nine paralytic cases were reported among immunologically normal recipients of OPV from 1980 through 1994. The overall risk to these recipients was one VAPP case per 6.2 million OPV doses. However, 40 (81.6%) of these 49 cases occurred following receipt of the first dose. The risk of VAPP was 1 case per 1.4 million first doses. The risk for all other doses was one per 27.2 million doses. The reason for this difference by dose is not known with certainty, but is probably because the vaccine virus is able to replicate longer in a completely nonimmune infant. This prolonged replication increases the chance of the emergence of a revertant virus that may cause paralysis. The situation is similar for contacts. A nonimmune child may shed virus longer, increasing the chance of exposure of a contact.

Contraindications and Precautions to Vaccination

Serious allergic reaction to a vaccine component, or following a prior dose of vaccine, is a contraindication to further doses of that vaccine. Since IPV contains trace amounts of streptomycin, neomycin, and polymyxin B, there is a possibility of allergic reactions in individuals sensitive to these antibiotics. Persons with allergies that are not anaphylactic, such as skin contact sensitivity, may be vaccinated.

Moderate or severe acute illness is a precaution for both IPV and OPV. However, mild illness, including mild diarrhea, is not a contraindication.

Breast feeding does not interfere with successful immunization against poliomyelitis with IPV or OPV. A dose of IPV may be administered to a child with diarrhea. Minor upper respiratory illnesses with or without fever, mild to moderate local reactions to a previous dose of vaccine, current antimicrobial therapy, and the convalescent phase of an acute illness are not contraindications for vaccination with IPV or OPV.

OPV should not be given to **immunodeficient individuals** or **household contacts of individuals who have immune deficiency** diseases, immune depression (due to disease or therapy), or if there is suspected familial immune deficiency. IPV may be substituted for OPV in these circumstances.

If OPV is inadvertently administered to a household contact of an immunodeficient patient, the patient and the recipient of OPV should avoid close contact for approximately 4-6 weeks after vaccination. If this is not feasible, rigorous hygiene and hand washing after contact with feces (*e.g.*, after diaper changing) and avoidance of contact with saliva (*e.g.*, sharing food or utensils) may be an acceptable, but probably less effective alternative. Maximum excretion of vaccine virus occurs within 4 weeks after oral vaccination.

In general, neither OPV nor IPV should be given to **pregnant women** unless immediate protection is needed (in which case OPV is the vaccine of choice, if available).

Contraindications and Precautions

- Serious allergic reaction to component or following prior dose (OPV/IPV)
- Moderate or severe febrile illness (OPV/IPV)
- Immunodeficiency (OPV)
- Household contact of immunodeficient person (OPV)
- Pregnancy (OPV)

Storage and Handling

OPV

The vaccine should arrive frozen on dry ice. It should be maintained at a temperature of 0°C (32°F) or lower and may be in either a frozen or liquid state. Unopened vaccine may be thawed and refrozen for a maximum of 10 freeze-thaw cycles, if the total cumulative duration of thaw does not exceed 24 hours and provided the temperature does not exceed 8°C (46°F) during the periods of the thaw. Unopened vaccine may be used for up to 30 days if stored between 2°-8°C (35°-46°F). Opened multiple-dose vials of vaccine can be used for up to 7 days if stored at 2°-8°C. The

vaccine should be pink or red.

IPV

The vaccine may be shipped without refrigeration provided it is delivered within 4 days. It should be maintained at 2°-8°C (35°-46°F). The vaccine should be perfectly clear and colorless. Any vaccine showing particulate matter, turbidity, or change in color, should be discarded.

Outbreak Investigation and Control

Collect preliminary clinical and epidemiological information (including vaccine history and contact with OPV vaccines) on any suspected case of paralytic polio. Notify the National Immunization Program, Centers for Disease Control and Prevention ([404] 639-8255) after all appropriate local and state health authorities have been notified. Intensify field investigation to verify information and collect appropriate specimens for viral isolates and serology.

Even one case of paralytic poliomyelitis demands immediate attention. If the evidence indicates vaccine-associated disease, then no outbreak control program is needed. If, however, evidence indicates wild virus (for example, two cases in a community), then all unvaccinated individuals in the epidemic area who are over 6 weeks of age and whose vaccine histories are uncertain should be vaccinated.

Polio Eradication

Polio Eradication

- Last case in United States in 1979
- Last case in Western Hemisphere in 1991
- Western Hemisphere certified polio free in 1994
- Global eradication goal by 2000

Following the widespread use of poliovirus vaccine in the mid-1950s, the incidence of poliomyelitis declined rapidly in many industrialized countries. In the United States, the number of cases of paralytic poliomyelitis reported annually declined from >20,000 cases in 1952 to <100 cases in the mid-1960s. The last documented indigenous transmission of wild poliovirus in the United States was in 1979.

In 1985, the member countries of the Pan American Health Organization adopted the goal of eliminating poliomyelitis from the Western Hemisphere by 1990. The strategy to achieve this goal included increasing vaccination coverage; enhancing surveillance for suspected cases (i.e., surveillance for acute flaccid paralysis); and using supplemental immunization strategies such as national immunization days (NIDs), house-to-house vaccination, and containment activities. Since 1991, when the last wild-virus-associated indigenous case was reported from Peru, no additional cases of poliomyelitis have been confirmed despite intensive surveillance. In September 1994, an international commission certified the Western hemisphere to be free of indigenous wild poliovirus. The com-

mission based its judgment on detailed reports from national certification commissions that had been convened in every country in the region.

In 1988, the World Health Assembly (the governing body of the World Health Organization) adopted the goal of global eradication of poliomyelitis by the year 2000. Substantial progress toward meeting this objective has already been achieved in many WHO regions, including East Asia, the Middle East, Southern and Eastern Africa, and Europe. By the end of 1998, almost all polio-endemic countries had conducted NIDs. The number of reported cases of paralytic polio, as well as the number of countries reporting cases, has decreased significantly since the global eradication program began. In 1997, over half of all polio was reported from the Indian subcontinent (the S.E. Asian region of WHO). Polio is still endemic in parts of the Eastern Mediterranean and Africa.

The polio eradication initiative is supported by a coalition of international organizations that includes WHO, the United Nations children's Fund (UNICEF), and other bilateral and multilateral organizations. Rotary International has contributed more than \$240 million to support the eradication initiative.

Post-Polio Syndrome

After an interval of 30-40 years, 25%-40% of people who contracted paralytic poliomyelitis in childhood experience new muscle pain and exacerbation of existing weakness, or develop new weakness or paralysis. This disease entity is referred to as post-polio syndrome. Factors that enhance the risk of post-polio syndrome include increasing length of time since acute poliovirus infection, presence of permanent residual impairment after recovery from the acute illness, and female gender. The pathogenesis of post-polio syndrome is thought to involve the failure of oversized motor units created during the recovery process of paralytic poliomyelitis. Post-polio syndrome is not an infectious process, and persons experiencing the syndrome do not shed poliovirus.

Several support groups have been established to assist and provide information to persons with post-polio syndrome, and their families.

International Polio Network
5100 Oakland Avenue, #206
St. Louis, MO 63110-1406
(314) 534-0475

March of Dimes
Birth Defects Foundation
Community Services Dept
1275 Mamaroneck Ave.
White Plains, NY 10605

Wild Poliovirus 1988



Wild Poliovirus 1998



(914) 428-7100

Selected References

American Academy of Pediatrics. Poliomyelitis prevention: revised recommendations for use of inactivated and live oral poliovirus vaccines. *Pediatrics* 1999;103:171-2.

CDC. Notice to Readers: recommendations of the Advisory Committee on Immunization Practices: revised recommendations for routine poliomyelitis vaccination. *MMWR* 1999;48:590.

CDC. Progress toward global poliomyelitis eradication, 1997-1998. *MMWR* 1999;48:416-21.

CDC. Impact of the sequential IPV/OPV schedule on vaccination coverage levels - United States, 1997. *MMWR* 1998;47:1017-19.

CDC. Poliomyelitis prevention in the United States: Introduction of a sequential vaccination schedule of inactivated poliovirus vaccine followed by oral poliovirus vaccine. Recommendations of the Advisory Committee on Immunization Practices. (ACIP). *MMWR* 1997;46(RR-3):1-25.

CDC. Paralytic poliomyelitis - United States, 1980-1994. *MMWR* 1997;46:79-83.

CDC. Certification of poliomyelitis eradication - the Americas, 1994. *MMWR* 1994;43:720-2.

Patriarca PA, Wright PS, John TJ. Factors affecting immunogenicity of oral poliovirus vaccine in developing countries: review. *Rev Infect Dis* 1991;13:926-39.

Prevots DR, Sutter RW, Strebel PM, et al. Completeness of reporting for paralytic poliomyelitis, United States, 1980-1991. Implications for estimating the risk of vaccine-associated disease. *Arch Pediatr Adolesc Med* 1994;148:478-85

Strebel PM, Sutter RW, Cochi SL, et al. Epidemiology of poliomyelitis in the United States: one decade after the last reported case of indigenous wild virus-associated disease. *Clin Infect Dis* 1992;14:568-79.

Sutter RW, Brink EW, Cochi SL, et al. A new epidemiologic and laboratory classification system for paralytic poliomyelitis cases. *Am J Public Health* 1989;79:495-8.